CLAIMS

1. An audio encoding system comprising:

a memory for storing a predetermined function which gives, for a given set of audio signal values, a probability density for parameters of a predetermined audio model which is assumed to have generated the set of audio signal values, the probability density defining, for a given set of model parameter values, the probability that the predetermined audio model has those parameter values, given that the model is assumed to have generated the set of audio signal values;

means for receiving a set of audio signal values representative of an input audio signal;

means for applying the set of received audio signal values to said stored function to give the probability density for said model parameters for the set of received audio signal values;

means for processing said function with said set of received audio signal values applied, to derive samples of parameter values from said probability density;

means for analysing at least some of said derived samples of parameter values to determine parameter values that are representative of the set of received audio signal values; and

means for encoding said determined parameter values to generate encoded data representative of the received audio signal values.

2. A system according to claim 1, wherein said processing means is operable to draw samples iteratively from said probability density function.

3. A system according to claim 2, wherein said processing means comprises a Gibbs sampler.

4. A system according to claim 2, wherein said analysing means is operable to determine a histogram of said drawn samples and wherein said values of said parameters are determined from said histogram.

5. A system according to claim 4, wherein said processing means is operable to determine said values of said first parameters using a weighted sum of said drawn samples and wherein the weighting for each sample is determined from said histogram.

6. A system according to claim 1, wherein said receiving means is operable to receive a sequence of sets of signal values representative of an input audio signal

and wherein said applying means, processing means and analysing means are operable to perform their function with respect to each set of received audio signal values to determine parameter values that are representative of each set of received audio signal values.

7. A system according to claim 6, wherein said processing means is operable to use the values of parameters obtained during the processing of a preceding set of signal values as initial estimates for the values of the corresponding parameters for a current set of signal values being processed.

8. A system according to claim 6, wherein said sets of signal values in said sequence are non-overlapping.

9. A system according to claim 6, wherein said processing means comprises means for varying the number of parameters used to represent the audio signal within each set of audio signal values.

10. A system according to claim 1, wherein said audio model comprises an auto-regressive process model and wherein said parameters include auto-regressive model coefficients.

11. A system according to claim 1, wherein said received set of audio signal values are representative of an input speech signal.

12. A system according to claim 11, wherein said received set of speech signal values are representative of a speech signal generated by a speech source as distorted by a transmission channel between the speech source and the receiving means; wherein said predetermined function includes a first part having first parameters which models said source and a second part having second parameters which models said channel; wherein said processing means is operable to derive samples of at least said first parameters; and wherein said analysing means is operable to determine values of said first parameters that are representative of said speech generated by said speech source before it was distorted by said transmission channel.

13. A system according to claim 12, wherein said function is in terms of a set of raw speech signal values representative of speech generated by said source before being distorted by said transmission channel, wherein the system further comprises second processing means for processing the received set of signal values with initial

estimates of said first and second parameters, to generate an estimate of the raw speech signal values corresponding to the received set of signal values and wherein said applying means is operable to apply said estimated set of raw speech signal values to said function in addition to said set of received signal values.

14. A system according to claim 13, wherein said second processing means comprises a simulation smoother.

15. A system according to claim 13, wherein said second processing means comprises a Kalman filter.

16. A system according to claim 12, wherein said second part is a moving average model and said second parameters comprise moving average model coefficients.

17. A system according to claim 1, further comprising means for evaluating said probability density function for the set of received signal values using one or more of said drawn samples of parameter values for different numbers of parameter values, to determine respective probabilities that the predetermined signal model has those parameter values and wherein said processing means

is operable to process at least some of said drawn samples of parameter values and said evaluated probabilities to determine said values of said parameters that are representative of the received audio signal.

18. A system according to claim 1, wherein said analysing means is operable to analyse at least some of said derived samples of parameter values to determine a measure of the variance of at least some of said samples of parameter values; wherein said system further comprises means for determining an indication of the quality of the received audio signal using said variance measure; and wherein said encoding means is operable to encode said determined parameter values in dependence upon the determined quality indication.

19. A system according to claim 18, wherein said encoding means is operable to encode said parameter values using a first encoding technique if said quality indication is above a predetermined value and is operable to encode said parameter values using a second encoding technique if said quality indication is below said value.

20. A system according to claim 19, wherein said first encoding technique is operable to minimise the data to be

transmitted and wherein said second encoding technique is operable to minimise information lost in the encoding.

21. An audio transmission system comprising:

a transmission unit comprising: means for receiving an audio signal; an audio encoding system according to claim 1 for generating encoded parameter values representative of received audio signal values; and means for transmitting the encoded parameter values; and a receiver unit comprising means for receiving the transmitted parameter values; and means for processing the received parameter values to generate an output signal in dependence thereon.

22. A system according to claim 21, wherein said processing means of said receiving unit comprises speech synthesis means for generating a synthesised speech signal in dependence upon the received parameter values.

23. A system according to claim 21, wherein said processing means of said receiving unit comprises a speech recognition system which operable to compare the received parameter values with stored reference models to generate a recognition result.

24. A system according to claim 21, wherein said transmission unit is operable to transmit said quality indication to said receiving unit and wherein said receiving unit is operable to receive said quality indication and to decode said encoded parameters in dependence upon the received quality indication.

25. A system according to claim 24, wherein said receiving unit is operable to decode said encoded parameter values in accordance with a first decoding technique if said quality indication has a value above a predetermined threshold value and is operable to decode said encoded parameter values in accordance with a second decoding technique if said quality indication is below said predetermined value.

26. An audio transmission system comprising a transmitter and receiver, wherein

the transmitter comprises:

means for receiving an input audio signal;

means for determining a measure of the quality of the input audio signal;

means for encoding data representative of the audio signal in dependence upon the determined quality measure; and

means for transmitting the encoded audio data; and wherein

said receiver comprises:

means for receiving the encoded audio data;

means for decoding the transmitted audio data; and

means for outputting the decoded audio data.

27. A system according to claim 26, wherein said transmitter is operable to transmit said quality measure and wherein said decoder is operable to decode said encoded audio data in dependence upon the received quality measure.

28. A system according to claim 26, wherein said encoder is operable to encode said audio signal in accordance with a first encoding technique if said quality measure is above a predetermined threshold and is operable to encode said audio signal in accordance with a second encoding technique if said quality measure is below a predetermined threshold.

29. A system according to claim 28, wherein said first encoding technique is operable to minimise the data to be transmitted and where said second encoding technique is

operable to minimise information lost in the encoding.

30. An audio transmission system comprising a transmission unit and a receiving unit, wherein

the transmission unit comprises:

a memory for storing a predetermined function which gives, for a given set of audio signal values, a probability density for parameters of a predetermined audio model which is assumed to have generated the set of audio signal values, the probability density defining, for a given set of model parameter values, the probability that the predetermined audio model has those parameter values, given that the model is assumed to have generated the set of audio signal values;

means for receiving a set of audio signal values representative of an input audio signal;

means for applying the set of received audio signal values to said stored function to give the probability density for said model parameters for the set of received audio signal values;

means for processing said function with said set of received audio signal values applied, to derive samples of parameter values from said probability density;

means for analysing at least some of said

derived samples of parameter values to determine parameter values that are representative of the set of received audio signal values; and

means for transmitting said determined parameter values; and wherein

the receiver unit comprises:

means for receiving said transmitted parameter values; and

means for processing the received parameter values to generate an output signal in dependence thereon.

31. A system according to claim 30, wherein said transmission unit further comprises means for encoding the determined parameter values and wherein said receiving unit comprises means for decoding the encoded parameter values.

32. A transmitter apparatus comprising:

a memory for storing a predetermined function which gives, for a given set of audio signal values, a probability density for parameters of a predetermined audio model which is assumed to have generated the set of audio signal values, the probability density defining, for a given set of model parameter values, the

probability that the predetermined audio model has those parameter values, given that the model is assumed to have generated the set of audio signal values;

means for receiving a set of audio signal values representative of an input audio signal;

means for applying the set of received audio signal values to said stored function to give the probability density for said model parameters for the set of received audio signal values;

means for processing said function with said set of received audio signal values applied, to derive samples of parameter values from said probability density;

means for analysing at least some of said derived samples of parameter values to determine parameter values that are representative of the set of received audio signal values; and

means for transmitting said determined parameter values.

33. A transmitter apparatus comprising:

means for receiving an input audio signal;

means for determining a measure of the quality of the input audio signal;

means for encoding data representative of the audio signal in dependence upon the determined quality measure;

and

means for transmitting the encoded data.

34. A transmitter according to claim 33, wherein said transmitting means is operable to transmit said quality measure in addition to said encoded data.

35. A transmitter according to claim 33, wherein said encoder is operable to encode said audio signal in accordance with a first encoding technique if said quality measure is above a predetermined threshold and is operable to encode said audio signal in accordance with a second encoding technique if said quality measure is below a predetermined threshold.

36. A transmitter according to claim 35, wherein said first encoding technique is operable to minimise the data to be transmitted and wherein said second encoding technique is operable to minimise information lost in the encoding.

37. An audio encoding method comprising the steps of:

storing a predetermined function which gives, for a given set of audio signal values, a probability density for parameters of a predetermined audio model which is

assumed to have generated the set of audio signal values, the probability density defining, for a given set of model parameter values, the probability that the predetermined audio model has those parameter values, given that the model is assumed to have generated the set of audio signal values;

receiving a set of audio signal values representative of an input audio signal at a receiver;

applying the set of received audio signal values to said stored function to give the probability density for said model parameters for the set of received audio signal values;

processing said function with said set of received audio signal values applied, to derive samples of parameter values from said probability density;

analysing at least some of said derived samples of parameter values to determine parameter values that are representative of the set of received audio signal values; and

encoding said determined parameter values to generate encoded data representative of the received audio signal values.

38. A method according to claim 37, wherein said processing step draws samples iteratively from said

probability density function.

39. A method according to claim 38, wherein said processing step uses a Gibbs sampler.

40. A method according to claim 38, wherein said analysing step determines a histogram of said drawn samples and wherein said values of said parameters are determined from said histogram.

41. A method according to claim 40, wherein said processing step determines said values of said first parameters using a weighted sum of said drawn samples and wherein the weighting for each sample is determined from said histogram.

42. A method according to any of claim 37, wherein said receiving step receives a sequence of sets of signal values representative of an input audio signal and wherein said applying step, processing step and analysing step are performed for each set of received audio signal values to determine parameter values that are representative of each set of received audio signal values.

43. A method according to claim 42, wherein said processing step uses the values of parameters obtained during the processing of a preceding set of signal values as initial estimates for the values of the corresponding parameters for a current set of signal values being processed.

44. A method according to claim 42, wherein said sets of signal values in said sequence are non-overlapping.

45. A method according to claim 42, wherein said processing step comprises the step of varying the number of parameters used to represent the audio signal within each set of audio signal values.

46. A method according to claim 37, wherein said audio model comprises an auto-regressive process model and wherein said parameters include auto-regressive model coefficients.

47. A method according to claim 37, wherein said received set of audio signal values are representative of an input speech signal.

48. A method according to claim 47, wherein said

received set of speech signal values are representative of a speech signal generated by a speech source as distorted by a transmission channel between the speech source and the receiver; wherein said predetermined function includes a first part having first parameters which models said source and a second part having second parameters which models said channel; wherein said processing step derives samples of at least said first parameters; and wherein said analysing step determines values of said first parameters that are representative of said speech generated by said speech source before it was distorted by said transmission channel.

49. A method according to claim 48, wherein said function is in terms of a set of raw speech signal values representative of speech generated by said source before being distorted by said transmission channel, further comprising a second processing step for processing the received set of signal values with initial estimates of said first and second parameters, to generate an estimate of the raw speech signal values corresponding to the received set of signal values and wherein said applying step applies said estimated set of raw speech signal values to said function in addition to said set of received signal values.

50. A method according to claim 49, wherein said second processing step uses a simulation smoother.

51. A method according to claim 49, wherein said second processing step uses a Kalman filter.

52. A method according to claim 48, wherein said second part is a moving average model and said second parameters comprise moving average model coefficients.

53. A method according to claim 37, further comprising the step of evaluating said probability density function for the set of received signal values using one or more of said drawn samples of parameter values for different numbers of parameter values, to determine respective probabilities that the predetermined signal model has those parameter values and wherein said processing step processes at least some of said drawn samples of parameter values and said evaluated probabilities to determine said values of said parameters that are representative of the received audio signal.

54. A method according to claim 37, wherein said analysing step analyses at least some of said derived samples of parameter values to determine a measure of the

variance of at least some of said samples of parameter values; further comprising the step of determining an indication of the quality of the received audio signal; and wherein said encoding step encodes said determined parameter values in dependence upon the determined quality indication.

55. A method according to claim 54, wherein said encoding step encodes said parameter values using a first encoding technique if said quality indication is above a predetermined value and encodes said parameter values using a second encoding technique if said quality indication is below said value.

56. A method according to claim 55, wherein said first encoding technique is operable to minimise the data to be transmitted and wherein said second encoding technique is operable to minimise information lost in the encoding.

57. An audio transmission method comprising the steps of:

receiving an audio signal at a transmission unit;

encoding the audio signal using a method according to claim 37 to generate encoded parameter values

representative of the audio signal; and

transmitting the encoded parameters values;

receiving the transmitted encoded parameter values at a receiver unit;

decoding the received encoded parameter values;

processing the decoded parameter values to generate and output signal in dependence thereon.

58. A method according to claim 37, wherein said processing step at said receiving unit comprises speech synthesis means for generating a synthesised speech signal in dependence upon the received parameter values.

59. A method according to claim 37, wherein said processing step at said receiving unit uses a speech recognition system to compare the received parameter values with stored reference models and to generate a recognition result.

60. A method according to claim 57, further comprising the step of transmitting said quality indication to said receiving unit and, at said receiving unit, the steps of receiving said quality indication and decoding said encoded parameters in dependence upon the received quality indication.

61. A method according to claim 60, comprising the step of, at said receiving unit, decoding said encoded parameter values in accordance with a first decoding technique if said quality indication has a value above a predetermined threshold value and decoding said encoded parameter values in accordance with a second decoding technique if said quality indication is below said predetermined value.

62. An audio transmission method using a transmitter and receiver, the method comprising the steps of:

at the transmitter:

receiving an audio signal;

determining a measure of the quality of the received audio signal;

encoding data representative of the audio signal in dependence upon the determined quality measure; and

transmitting the encoded data; and

at said receiver:

receiving the encoded audio data;

decoding the transmitted audio data; and

outputting the decoded audio data.

63. A method according to claim 62, further comprising

the step of, at said transmitter, transmitting said quality measure and wherein said decoding step decodes said encoded audio data in dependence upon the received quality measure.

64. A method according to claim 61, wherein said encoding step encodes said audio signal in accordance with a first encoding technique if said quality measure is above a predetermined threshold and encodes said audio signal in accordance with a second encoding technique if said quality measure is below a predetermined threshold.

65. A method according to claim 63, wherein said first encoding technique is operable to minimise the data to be transmitted and where said second encoding technique is operable to minimise information lost in the encoding.

66. An audio transmission method using a transmission unit and a receiving unit, wherein the method comprises the steps of:

at the transmission unit:

storing a predetermined function which gives, for a given set of audio signal values, a probability density for parameters of a predetermined audio model which is assumed to have generated the set of audio

signal values, the probability density defining, for a given set of model parameter values, the probability that the predetermined audio model has those parameter values, given that the model is assumed to have generated the set of audio signal values;

receiving a set of audio signal values representative of an input audio signal;

applying the set of received audio signal values to said stored function to give the probability density for said model parameters for the set of received audio signal values;

processing said function with said set of received audio signal values applied, to derive samples of parameter values from said probability density;

analysing at least some of said derived samples of parameter values to determine parameter values that are representative of the set of received audio signal values; and

transmitting said determined parameter values; and

at the receiver unit:

receiving said transmitted parameter values; and

processing the received parameter values to generate an output signal in dependence thereon.

67. A computer readable medium storing computer executable process steps to cause a programmable computer apparatus to perform the method of claim 37.

68. Processor implementable process steps for causing a programmable computing device to perform the method according to claim 37.